

- 24 -

**CLAIMS**

1. An article comprising shape memory material arranged such that, in use, upon shape transition of the shape memory material, first and second portions of the article are pushed apart by a force exerted between the first and second portions.
2. An article according to claim 1, wherein the shape memory material is operative, upon shape transition, to generate a separation force to urge said first and second portions apart.
3. An article in which shape memory material is provided for assisting disassembly of the article, the shape memory material being operative upon shape transition to exert a force between first and second portions of the article to urge separation of the two portions.
4. An article according to claim 2 or 3, wherein the first and second portions are integral with each other, and the shape memory material is operative to shear a region connecting the first and second portions.
5. An article according to claim 4, wherein the shape memory material is embedded or inserted in the region connecting the first and second portions.
6. An article according to claim 2 or 3, wherein the first and second portions are distinct parts fastened together in assembled relation, and the shape memory material is operative to exert sufficient force to overcome the fastening.
7. An article according to claim 6, wherein the fastening comprises a snap fit connection.
8. An article according to claim 6, wherein the first and second parts are

5

10

15

20

00904377.112601  
T09217EE6660

WO 98/26187

- 25 -

fastened together by welding.

9. An article according to claim 6, wherein the first and second parts are fastened together by adhesive.

10. An article according to any of claims 1 to 9, wherein the shape memory material is provided in the form of an annular element or a helical coil element which, upon shape transition, lengthens generally in an axial direction.

11. An article according to any of claims 1 to 9, wherein the shape memory material is provided in the form of an elongate element which, upon shape transition, bends to generate a separation force.

12. An article according to claim 11, wherein the elongate element comprises a generally straight elongate portion.

13. An article according to any of claims 1 to 9, wherein the shape memory material is in the form of curved or bent element which is operative to uncurve, or unbend, at least partly to generate a separation force.

14. An article according to any of claims 1 to 13, wherein the shape memory material is provided in the form of an element which, upon shape transition, changes its cross sectional shape to generate a separation force.

15. An article according to any preceding claim, wherein the shape memory material forms, or forms part of, a releasable fastener for fastening together the first and second portions of the article.

16. An article according to claim 15, wherein the shape memory material forms an engagement or gripping portion of the releasable fastener.

00904337-112001  
T03211-26187

WO 98/26187

- 26 -

17. An article comprising a releasable fastener for fastening together first and second portions of the article, the releasable fastener comprising at least one fastener engagement or gripping portion comprising shape memory material, the shape memory material being operative upon shape transition to change shape at least partly to release engagement of the fastener.
18. An article according to any preceding claim, wherein the shape material is a shape memory alloy.
19. An article according to claim 18, wherein the alloy includes nickel and titanium.
20. An article according to claim 18, wherein the alloy includes zinc, copper and aluminium.
21. An article according to claim 18, 19 or 20, wherein the shape memory material forms at least part of an element for holding and establishing an electrical connection to an electrical or electronic component, the shape memory alloy being operative to release engagement with the component upon shape transition.
22. An article according to claim 21, wherein the shape memory alloy forms part of a socket for receiving an integrated circuit.
23. An article according to any of claims 1 to 17, wherein the shape memory material is a shape memory polymer.
24. An article in which shape memory polymer is provided for assisting disassembly of the article, the shape memory polymer being operative upon shape transition to release a first portion of the article from a second portion.

5

10

15

20

0904337.11201  
T09211.22E4660

WO 98/26187

- 27 -

25. An article according to claim 24, wherein the shape memory polymer forms, or forms part of, a releasable fastener for releasably fastening together the first and second portions.
26. An article according to claim 16, 17 or 25, or to any claim dependent thereon, wherein the releasable fastener comprises a jaw or retainer which is displaceable to release the fastening.
27. An article according to any preceding claim, wherein the shape memory material is comprised in a strap or band which fits around the first and second portions to hold the portions in assembled relation, the shape memory material being operative upon shape transition to at least partly loosen the band or strap.
28. An article according to claim 27, wherein the shape memory material is operative upon shape transition to unwrap at least the end portions of the band or strap to release the band or strap.
29. An article according to claim 27 or 28, wherein the strap or band is made substantially entirely of shape memory material.
30. An article according to claim 16, 17 or 25, or to any claim dependent thereon, wherein the releasable fastener is in the form of an element for threadedly engaging a complementary fastener, the releasable fastener being operative upon transition to change shape to release threaded engagement with the complementary fastener.
31. An article according to claim 16, 17, or 25, or to any claim dependent thereon, wherein the releasable fastener comprises a female element for receiving a male element.
32. An article according to claim 31, wherein the shape memory material is

10  
09943777  
159277 26187

WO 98/26187

- 28 -

operative upon shape transition to change the shape of an engagement surface of the female element to release a said male element received therein.

33. An article according to claim 32, wherein the shape memory material is operative to change the cross-sectional shape of at least the engagement surface of the female element from generally oval to generally round, in order to increase the minimum radial dimension of the cross-section and thereby release the male element.

34. An article according to claim 32 or 33, wherein the female element comprises a generally annular member, and wherein the shape memory material is operative upon shape transition to cause the female element to lengthen in a generally axial direction and concurrently to enlarge the inner diameter of the female member, thereby to release engagement with the male element, and to generate a separation force in the axial direction.

35. An article according to claim 16, 17 or 25, or to any claim dependent thereon, wherein the releasable fastener comprises a male element for engagement in a female element.

36. An article according to claim 35, wherein the male element is threaded.

37. An article according to claim 35 or 36, wherein the shape memory material is operative upon shape transition to change the cross-sectional shape of the shank of the screw to release engagement with the female member.

38. An article according to claim 37, wherein the shape memory material is operative to change the cross-sectional shape from generally oval to generally round, in order to decrease the maximum radial dimension of the cross-section, and thereby release engagement with the female member.

5

10

0994337-11601  
T09T-2E24660

15

20

WO 98/26187

- 29 -

39. An article according to any preceding claim, comprising first and second elements of shape memory material, the second element having a different shape transition temperature from the first element, whereby sequential shape memory material assisted disassembly operations can be performed.

40. An article comprising first and second elements of shape memory material for assisting disassembly of the article, the first element having a different shape transition temperature from the second element, whereby sequential shape memory assisted disassembly operations can be performed.

41. An article comprising first and second elements of shape memory material, each element being operative upon shape transition to assist disassembly of respective portions of the article, the first and second elements being arranged or configured such that the first element can be triggered to change shape independently of the second element, whereby sequential shape memory material assisted disassembly operations can be performed.

42. A method of producing or assembling an article as defined in any preceding claim, the method comprising fitting at least one element of shape memory material in or to the article in such a manner that, upon shape transition, the shape memory material is operative to assist disassembly of the article.

43. A method of at least partially disassembling an article as defined in any of claims 1 to 40, the method comprising triggering shape transition of at least one element of shape memory material in or on the article, thereby to cause release and/or to urge separation of a first portion of the article relative to a second portion.

44. A method according to claim 43, comprising changing the temperature of the shape memory material to exceed, or drop below, the transition temperature of the material.

10  
13  
15  
20  
25  
FOIA b7 - D

WO 98/26187

- 30 -

45. A method according to claim 44, wherein the temperature change is achieved by placing the article in a region of elevated or reduced temperature.

46. A method according to claim 44 or 45, comprising subjecting the article to a temperature gradient for triggering sequential disassembly at different temperatures.

47. A fastening element comprising shape memory polymer, the shape memory material being operative upon shape transition to change or relax its shape to release fastening engagement.

48. An element according to claim 45, wherein the element consists substantially entirely of shape memory polymer.

49. An element according to claim 47 or 48, comprising, at least under ambient temperature conditions, a threaded portion.

50. An element according to claim 47 or 48, wherein the element is in the form of a strap or band for wrapping around parts to be fastened.

51. A releasable fastener for releasably fastening a first part to a second part, the fastener comprising a first engagement region for engaging the first part and a second engagement region for engaging the second part, at least the first engagement region comprising shape memory material operative upon shape transition to change shape to release or relax the engagement.

52. A releasable fastener according to claim 51, wherein the first region comprises at least one jaw.

53. A releasable fastener according to claim 51 or 52, wherein the first region comprises a mouth in which the first part is received.

WO 98/26187

- 31 -

54. A releasable fastener according to claim 51, wherein the fastener comprises a tube or an annulus, one of the first and second engagement regions comprising a radially inner portion of the tube or annulus, and the other region comprising a radially outer portion of the tube or annulus.

55. A releasable fastener according to claim 51, 53 or 54, wherein the fastener has a generally oval cross sectional shape under ambient temperature conditions, and is operative to change shape to a generally round cross-section upon shape transition.

56. A releasable fastener according to any of claims 51 to 55, wherein the shape memory material comprises a shape memory alloy.

57. A releasable fastener according to claim 56, wherein the alloy includes titanium and nickel.

58. A releasable fastener according to claim 56, wherein the alloy includes copper, zinc and aluminium.

59. A releasable fastener according to any of claims 51 to 55, wherein the shape memory material is a shape memory polymer.

60. An article including shape memory material to assist disassembly of the article, substantially as hereinbefore described with reference to the accompanying drawings.

61. A defastener substantially as hereinbefore described with reference to Figs. of the accompanying drawings.

62. A releasable fastener substantially as hereinbefore described with reference to Figs. of the accompanying drawings.

5

10

09904337.112601  
TOSTIT ZEEH6660

20



WO 98/26187

PCT/GB97/03392

- 32 -

63. A method of assembly or of disassembly of an article, the method being substantially as hereinbefore described with reference to the accompanying drawings.

64. Apparatus for triggering shape transition of shape memory material to assist disassembly of an article, the apparatus being substantially as hereinbefore described with reference to Fig. of the accompanying drawings.

T09211-2EE46660